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Outcomes of the pediatric patients undergoing pericardiocentesis for cardiac surgery-related massive pericardial effusion

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ABSTRACT

Aims: In this study, we aimed to evaluate the demographic and clinical characteristics of the patients who have moderate or severe cardiac surgery related pericardial effusion and relieved by pericardiocentesis.

Methods: Twenty-one children (0-18 years of age) were identified retrospectively in a 10-year period (2010-2020) and we reviewed our medical records for demographic and clinical characteristics, management strategies and outcome of the patients.

Results: Male to female ratio was 1.1, and mean age and body weight of the patients were 79.7±56.6 months and 19.5±14 kg respectively. Of the patients (33%) had at least one complaint, most common being dyspnea (19%) and fatigue (8.5%). The mean period between heart surgery and pericardiocentesis was 30.1±13.4 days. The distribution of surgical indications was as follows; atrial septal defect (42.8%), ventricular septal defect (23.8%), endocardial cushion defect (9.5%). The mean largest diameter of effusion and amount of fluid drained were 34.9±13.4 mm and 349.3±276.1 ml respectively. Macroscopic appearance of the fluid was serous in 28.5%, hemorrhagic in 66.7% and chylous in 4.8% patient. Of the 21 patients 13 were treated with anti-inflammatory drugs; NSAID (14.8%), NSAID and colchicine (33.3%) NSAID, colchicine and corticosteroid (14.8%). On the follow up 2 (9.5%) patient died because of sepsis and heart failure. There were no procedure related complication, chronic effusion or constriction on the follow up.

Conclusion: In conclusion, post-pericardiotomy syndrome can lead to serious consequences. Therefore, patients at risk should be identified in the post-operative period and a patient-specific follow-up plan should be made. In the presence of tamponade or massive effusion, pericardiocentesis is a safe, effective and life-saving procedure in patients unresponsive to medical treatment.

Keywords: Cardiac surgery, pericardial effusion, pericardiocentesis, post-pericardiotomy syndrome

INTRODUCTION

Pericardial effusion (PE) is a common complication after cardiac surgery and is mostly due to surgical bleeding and perioperative trauma in the first week after intervention. Post-pericardiotomy syndrome (PPS) after cardiac surgery is an inflammatory process due to opening of the pericardium, pleural or both, can occur a few days to several weeks after surgery.[1,2] PPS was first described in the 1950s after rheumatic mitral stenosis surgery.[3] In studies, the frequency of PPS and PE after surgery has been reported as 3-43%, and the frequency of cardiac tamponade is 1-2%.[4-6] The median duration of the syndrome is generally 2–3 weeks with possible relapses occuring in several months after initial onset. Although the exact pathogenesis of PPS is not known, it is accepted that PPS develops as a result of an immune-related inflammatory process. Pleuropericardial injury is thought to trigger both local and systemic inflammatory/immune responses, primarily involving the pericardium and pleura. Damage to mesothelial cells and bleeding into the pericardial and pleural spaces cause the production of autoantibodies, which lead to antigen presentation and deposition of immune complexes in the pleuropericardial sac.[1,2] Diagnosis is made clinically by the presence of two of the following; I) fever without alternative causes, II) pericarditic or pleuritic chest pain, III) pericardial or pleural rubs, IV) evidence of PE and/or V) pleural effusion with elevated CRP.[1] PPS is mild in most patients and regresses spontaneously or with anti-inflammatory therapy. NSAID and colchicine are the first line therapy and corticosteroids are used in severe cases, however in case of tamponade or large effusion pericardiocentesis or surgical drainage may be necessary.

In our study we aimed to evaluate the demographic and clinical characteristics of patients who underwent PC due to cardiac surgery related massive PE.

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METHODS

The study was conducted with the permission of the Clinical Researches Ethics Committee of Health Sciences University Ankara Pediatrics Hematology Oncology Hospital (Date: 19.04.2019, Decision No: 2019-092). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This study was conducted in Health Sciences University Dr. Sami Ulus Children Research and Training Hospital, Ankara, Turkiye. We identified 21 children (0-18 years of age) in a 10-year period (2010-2020) for moderate-to-large cardiac surgery related PE relieved by PC and reviewed medical records for demographic and clinical characteristics and management strategies.

Size of the effusion was recorded as maximum diameter between epicardium and pericardium measured during diastole. The presence of signs of tamponade (atrial or ventricular wall collapse etc.) were also determined**.** The amount, color and apperance of fluid obtained by PC was recorded. The results of microbiological (microscopic examination, culture) and biochemical analysis of the fluid was evaluated.

Data were analyzed with a statistical program and descriptive statistics were given as mean±standard deviation, minimum and maximum and percentages. Since it was a retrospective study, informed family consent form could not be obtained.

RESULTS

In the study period 21 patients were enrolled in the study. PC was performed via subxyphoid way in all of the patients.

Demographic and Clinical Findings

Male to female (M/F) ratio was 1.1. Mean age of the patients was 79.7±56.6 months (range btw 4.4-197 months) and the mean body weight (BW) was 19.5±14 kg during PC. Of the patients 6 (28%) were under 3 years of age.

Seven of the patients (33%) had at least one complaint, while the remaining (66.7%) had no complaints and were diagnosed during routine postoperative outpatient clinic control. Considering the presenting complaints, 4 (19%) patients had dyspnea, 2 patients had weakness (8.5%), 1 patient had abdominal pain (4.7%), and 1 patient had fainting (4.7%).

The mean period between cardiac surgery and PC was 30.1±13.4 days. The distribution of surgical indications was as follows; atrial septal defect (ASD) in 9 patients (42.8%), ventricular septal defect (VSD) in 5 patients (23.8%), endocardial cushion defect (ECD) in 2 patients (9.5%), infected thrombus resection, intracardiac mass resection (dystrophic calcification), Fontan operation and ALCAPA in 1 patient (4.7%) each (**Figure**).

Echocardiography, Pericardicentesis and Laboratory Data

The largest diameter of effusion was 34.9±13.4 mm (range btw15-60 mm), and 2.4±1 mm/kg (0.62–6.3 mm/kg) when indexed to BW. Echocardiographic signs of tamponade were present in 6 (28.6%) of the patients. The amount of fluid drained with PC was 349.3±276.1 ml (range btw 65–1400 ml) and 20.8±10.6 ml/kg (range btw 6.6-41.7) when indexed to BW. Macroscopic appearance of the fluid was serous in 6 (28.5%), hemorrhagic in 14 (66.7%) and chylous in 1 (4.8%) patient.

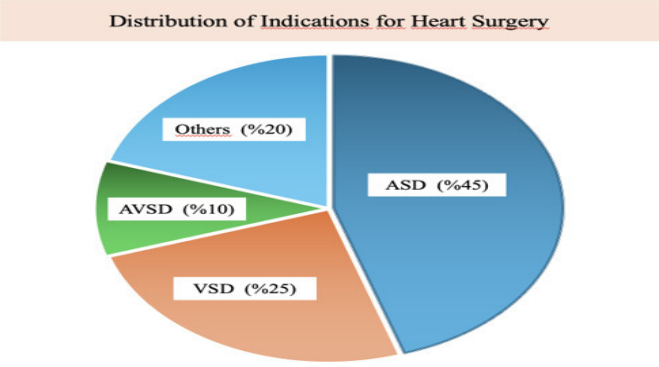

Figure. Indications for heart surgery in patients with PPS and large effusion relieved by PC
ASD: Atrial septal defect, VSD: Ventricular septal defect, AVSD: Atrioventricular septal defect

Laboratuary examination revealed mean erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) value of 23.5mm/hr and 8 mg/L, and elevated in 87.5% and 57.9% respectively. Mean hemoglobin, white blood cell and thromobcyte counts were 12.2±1.92 g/dl, 9.4x106/µl and 327.5x106/µl respectively. Pericardial fluid examination was negative for culture, viral PCR, mycobacterial culture, PCR and ARB.

Management and Outcome

Thirteen of 21 patients were treated with anti-inflammatory drugs; 3 (14.8%) received nonsteroidal anti-inflammatory drugs (NSAIDs), 7 (33.3%) received NSAIDs and colchicine, and 3 (14.8%) received NSAIDs, colchicine, and steroids. Surgical drainage was performed in 1 patient with recurrent effusion that was unresponsive to medical treatment. Ampirical antibiotic theraphy was given in 11 (57.9%) patients. On the follow up, 2 (9.5%) patient died because of sepsis and heart failure. No case of chronic effusion or constriction was observed during follow-up. The characteristics and results of the PPS patients are given in **Table**.

DISCUSSION

PPS is a diagnosis of exclusion characterized by fever, pericarditis and pleuritis. A significant portion of PE developing after cardiac surgery respond to anti-inflammatory treatment, however moderate and severe PE can progress to cardiac tamponade and may require urgent intervention. Relatively slow accumulation of fluid in postoperative patients causes the signs of tamponade to occur later than in patients with non-surgery related effusions. Studies have reported the incidence of PPS and PE as 3-43% and the incidence of tamponade as 1-2%.[6] Cheung et al.[7] followed patients with serial echocardiogram and found that 23% of the patients developed PE and in 13% of them had moderate to large PE. In the study of Elias et al.[6], it was reported that PC was applied in 44.2% of 1535 patients who developed PE after cardiac surgery, while it was reported 7% in an another study.[8] In our study, rate of PC and cardiac tamponade after

Table. The demographic and clinical characteristics of the PPS patients

Characteristics	n	%	Mean±SD	Min.-Max.
Sex				
Male	11	52.4		
Female	10	47.6		
Age (months)			79.7±56.6	4.4 - 197
<3 years	6	28.6		
≥3 years	15	71.4		
Body weight (kg)			19.5±14	3 - 6
Presenting complaint				
None	14	66.7		
At least one	7	33.3		
Echocardiography				
Tamponade	6	28.6		
Max. diameter (mm)			34.9±13.4	15-60
Max. diameter indexed to body weight (mm/kg)			2.4±1	0.62-6.33
Pericardiocentesis				
Post-op interval (day)			30.1±13.4	
Amount of fluid drained (ml)			349.2±276.1	65-1400
Amount of fluid drained indexed to body weight			20.8±10.6	6.6-41.7
Serous	6	28.5		
Hemorrhagic	14	66.7		
Chylous	1	4.8		
Laboratory				
Sedimentation rate (elevated in 87%)			23.5	7-55
CRP (elevated in 57%)			8	3-72
Leukocyte (x10⁶/µl)			9.4	5.35 – 23.25
Management				
NSAIDs	3	14.8		
NSAIDs+colchicine	7	33.3		
NSAIDs+colchicine+steroid	3	14.8		
Surgical drainage and tube placement	1	4.8		

Post-pericardiotomy syndrome, SD: Standard deviation, Min: Minimum, Max: Maximum, CRP: C-reactive protein, NSAIDs: Non-steroidal anti-inflammatory drugs

heart surgery were 0.2% and 0.06% respectively. Since only the patients withh severe effusion who underwent PC were included in the study, the overall PE rate was not given.

Among the patients in our study M/F ratio was 1.1. Dalili et al.[8] and Elias et al.[6] found no significant difference in terms of gender, however, Cheung et al.[7] reported female predominance with a M/F ratio of 0.54. When PE and PPS cases developed after cardiac surgery were evaluated, it was reported that female gender was a risk factor for re-admission.[5] In our study, although there was no significant difference in terms of gender, it was observed that the ratio of female sex was relatively increased when compared with the patients who underwent PC for reasons other than cardiac surgery in our center.

PPS is rare under 2 years of age and risk of PE increases with increasing age.[6,9] Elias et al.[6] found that 1535 of 142.633 surgical admissions had readmission for PE and they reported that mean age for patients with PE was significantly higher than that of without PE (24.5 months vs 6.4 years respectively). One study reported the average age of patients developing PPS after ASD surgery as 3.8 years, and another study reported that the risk doubled over the age of 5.[10,11] In a study with adult patients, the risk of PPS was found to be higher at younger ages.[12] This may be explained by a stronger immunological response ability in older children and also for younger adults. In our study, in accordance with the literature, 71.4% of the patients were over 3 years old with a mean age of 6.9 years.

Clinical findings and complaints in PE vary. At the time of admission, at least one complaint was reported in 33.3% of the patients, respiratory distress was found to be the most common. Similarly, in the literature, the rate of complaints was found to be low in patients who developed PE after cardiac surgery. While one study reported the presence of clinical findings as 23% in all patients with PE and 47.4% in those with severe effusion, another study found it to be only 19%.[7,8] Considering the high rate of patients without clinical symptoms and signs in some previous studies, it should be kept in mind that even atypical findings such as fatigue and abdominal pain may be associated with PPS, especially in patients who had undergone cardiac surgery and applied to the outpatient clinic or emergency department.

CRP and ESR are elevated along with neutrophilic leukocytosis in most PPS patients although their specificity is poor during the first weeks after cardiac surgery.[12-14] In the study of Heching et al.[10], laboratory tests were performed in 55% of the patients at the time of diagnosis, and it was reported that 44% had elevated CRP and 37% had elevated ESR. We found leukocytosis in 25%, CRP elevation in 57% and ESR elevation in 87.5% of the patients.

PPS develops after corrective surgeries and also occur after direct or indirect irritation of the pericardium after palliative interventions. In the literature, reported risk factors for PE and PPS after cardiac surgery were; presence of effusion before discharge, female gender, advanced age, use of warfarin, pleural incision, Ross procedure, ASD, valve operation, Fontan operation, AVSD, Blalock-Taussig shunt, heart transplantation Trisomy-21, winter and summer months, low platelet values, high lymphocyte values, low interleukin-8 levels, erythrocyte transfusion and renal failure.[2,5-8,15] In our study indication for heart surgery was ASD in 9 (42.8%) of 21 patients. The cause of PE in patients after ASD operation is thought to be due to the change in mechanical properties as a result of chronic exposure of the right atrium with pericardiotomy and right atriotomy. Elias et al.[6] reported that the response to medical treatment is less in PE related to ASD operation. Trisomy-21 is previously reported as a risk factor for PE, and hypothyroidism and abnormal myelopoesis were suggested as the cause of predisposisiton.[15-17]

Although PPS is typically seen in the first weeks after surgery, it can develop months after the operation. Dalili et al.[8] reported that PE developed in 87% of the patients within the

first 13 days after the operation and Cheung et al.[7] reported in 97% of the patients in the first 28 days after surgery. In our study, the mean interval between cardiac surgery and PC was 30.1±13.4 days (6-60 days) in line with the literature. For our patients, it was observed that the patients were advised for outpatient control at the end of first month. Considering that a significant portion of our patients who underwent PC for PPS did not report any complaints at the first control, it would be more appropriate to perform routine cardiology outpatient controls at shorter intervals after the surgical procedure.

Although it is important to evaluate the amount of fluid, of it should be noted that there is no correlation between the amount of fluid and clinical findings. In our study, the amount of effusion was evaluated by taking the largest diameters measured in diastole. Due to the different age groups and body weights of the patients, these measurements were also evaluated by proportioning their body weight. In patients with surgery related PE "Pediatric tamponade index (PTI) (amount of fluid drained for 24 hours with the inserted chest tube to body weight)" was defined and it was reported that, PTI>21were related with more severe clinical findings, longer hospital stay after PC and need for inotropic support before the procedure.[18]

For the treatment of PPS use of NSAIDs and colchicine, with the occasional addition of corticosteroids is recommended according to ESC guidelines.[1] It has been reported that there was no significant difference in the incidence of PPS in patients who were given short-term prophylactic methylprednisolone and acetylsalicylic acid treatments compared to the group that was not given.[19,20] In another study, it was reported that the incidence of PPS was statistically significantly lower at the end of 1 year in patients receiving prophylactic colchicine.[21] The use of ibuprofen or indomethacin for 10 days has been reported to relieve symptoms and shorten the duration of illness without causing significant side effects.[22] Giacinto et al.[23] reported a better outcome when colchicine and indomethacin were administered as primary prophylactic agents and Malektori et al.[24] recommend colchicine use to reduce the risk of the PPS. None of the patients in our study received prophylactic treatment.

In our center, subxiphoid percutaneous PC and/or pericardial catheter placement with a subxiphoid percutaneous approach is preferred. Minimally invasive surgical intervention is also preferred in some centers, and it is claimed to have advantages such as direct visualization of the pericardium and heart, opening of pericardial adhesions, and opening of the pericardial window when necessary.[18] Fields et al.[25] found no differences in efficacy, safety, and resource utilization between initial drainage through pericardial window compared to pericardiocentesis in children with PPS warranting fluid drainage. No serious complication related to the procedure was observed and the success of the procedure was high in our study. We think that surgical intervention is more appropriate in patients who require a pericardial window due to the locality of the effusion, the presence of widespread fibrous structures and the recurrent effusions.

Limitations

The retrospective nature of the study, the inclusion of only patients who underwent PC, and the inability to compare the initial clinical and laboratory findings with the results were considered limitations of the study.

CONCLUSION

PPS is an important post-operative complication and may cause significant consequences such as tamponade, requiring PC or surgical drainage. Considering that a significant portion of our patients who underwent PC for PPS did not report any complaints at the first control, it would be more appropriate to perform routine cardiology outpatient controls at shorter intervals after the surgical procedure especially in case of presence of reported risk factors. In patients unresponsive to medical treatment percutaneous PC is a safe and effective method along with anti-inflammatory drugs.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Clinical Researches Ethics Committee of Health Sciences University Ankara Pediatrics Hematology Oncology Hospital (Date: 19.04.2019, Decision No: 2019-092).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Adler Y, Charron P, Imazio M, et al. ESC Scientific Document Group. 2015 ESC Guidelines for the diagnosis and management of pericardial diseases: the Task Force for the diagnosis and management of pericardial diseases of the European Society of Cardiology (ESC) Endorsed by: The European Association for Cardio-Thoracic Surgery (EACTS). *Eur Heart J*. 2015;36:2921-2964. doi:10.1093/eurheartj/ehv318
2. Maranta F, Cianfanelli L, Grippo R, Alfieri O, Cianflone D, Imazio M. Post-pericardiotomy syndrome: insights into neglected postoperative issues. *Eur J Cardiothorac Surg*. 2022;61(3):505-514. doi:10.1093/ejcts/ezab449
3. Soloff LA, Zatuchui J, Janton OH, et al. Reactivation of rheumatic fever following mitral commissurotomy. *Circulation*. 1953;8(4):481-497. doi:10.1161/01.cir.8.4.481

4. Miller RH, Horneffer PJ, Gardner TJ, et al. The epidemiology of the postpericardiotomy syndrome: a common complication of cardiac surgery. *Am Heart J*. 1988;116(5 Pt 1):1323-1329. doi:10.1016/0002-8703(88)90457-7
5. Imazio M, Brucato A, Rovere ME, et al. Contemporary features, risk factors, and prognosis of the postpericardiotomy syndrome. *Am J Cardiol*. 2011;108(8):1183-1187. doi:10.1016/j.amjcard.2011.06.025
6. Elias MD, Glatz AC, O'Connor MJ, et al. Prevalence and risk factors for pericardial effusions requiring readmission after pediatric cardiac surgery. *Pediatr Cardiol*. 2016;38(3):484-494. doi:10.1007/s00246-016-1540-2
7. Cheung EWY, Ho SA, Tang KKY, Chau AKT, Chiu CSW, Cheung YF. Pericardial effusion after open heart surgery for congenital heart disease. *Heart*. 2003;89(7):780-783. doi:10.1136/heart.89.7.780
8. Dalili M, Zamani H, Aarabi-Moghaddam M. Pericardial effusion after pediatric cardiac surgeries: a single center observation. *Res Cardiovasc Med*. 2012;1(1):28-32. doi:10.5812/cardiovascmed.4601
9. Scarfone RJ, Donoghue AJ, Alessandrini EA. Cardiac tamponade complicating postpericardiotomy syndrome. *Pediatr Emerg Care*. 2003;19(4):268-271. doi:10.1097/01.pec.0000092573.40174.74
10. Heching HJ, Bacha EA, Liberman L. Post-pericardiotomy syndrome in pediatric patients following surgical closure of secundum atrial septal defects: incidence and risk factors. *Pediatr Cardiol*. 2015;36(3):498-502. doi:10.1007/s00246-014-1039-7
11. Jones DA, Radford DJ, Pohlner PG. Outcome following surgical closure of a secundum atrial septal defect. *J Paediatr Child Health*. 2001;37(3):274-277. doi:10.1046/j.1440-1754.2001.00659.x
12. Lehto J, Gunn J, Karjalainen P, Airaksinen J, Kiviniemi T. Incidence and risk factors of postpericardiotomy syndrome requiring medical attention: the Finland postpericardiotomy syndrome study. *J Thorac Cardiovasc Surg*. 2015;149(5):1324-1329. doi:10.1016/j.jtcvs.2015.01.031
13. Lehto J, Kiviniemi T. Postpericardiotomy syndrome after cardiac surgery. *Ann Med*. 2020;52(6):243-264. doi:10.1080/07853890.2020.1758339
14. Kohler I, Saraiva PJ, Wender OB, et al. Behavior of inflammatory markers of myocardial injury in cardiac surgery. Laboratory correlation with the clinical picture of postpericardiotomy syndrome. *Arq Bras Cardiol*. 2003;81(3):279-290. doi:10.1590/S0066-782X2003001100008
15. Noma M, Hirata Y, Hirahara N, et al. Pericardial effusion after congenital heart surgery. *JTCVS Open*. 2022;22(9):237-243. doi:10.1016/j.xjon.2022.01.001
16. Concolino D, Pascuzzi A, Pietragalla E, et al. High prevalence of isolated pericardial effusion in Down syndrome. *Am J Med Genet A*. 2005;132A(3):331-332. doi:10.1002/ajmg.a.30399
17. Hirashima C, Eguchi Y, Kohmura Y, Minakami H, Sato I. Isolated pericardial effusion and transient abnormal myelopoiesis in a fetus with Down's syndrome. *J Obstet Gynaecol Res*. 2000;26(4):303-306. doi:10.1111/j.1447-0756.2000.tb01326.x
18. Haponiuk I, Kwasniak E, Chojnicki M, et al. Minimally invasive transxiphoid approach for management of pediatric cardiac tamponade–one center's experience. *Wideochir Inne Tech Maloinwazyjne*. 2015;10(1):107-114. doi:10.5114/wiitm.2014.47690
19. Mott AR, Fraser CD Jr, Kusnoor AV, et al. The effect of short-term prophylactic methylprednisolone on the incidence and severity of postpericardiotomy syndrome in children undergoing cardiac surgery with cardiopulmonary bypass. *J Am Coll Cardiol*. 200;37(6):1700-1706. doi:10.1016/s0735-1097(01)01223-2
20. Gill PJ, Forbes K, Coe JY. The effect of short-term prophylactic acetylsalicylic acid on the incidence of post-pericardiotomy syndrome after surgical closure of atrial septal defects. *Pediatr Cardiol*. 2009;30(8):1061-1067. doi:10.1007/s00246-009-9495-1
21. Imazio M, Trinchero R, Brucato A, et al. Colchicine for the prevention of the post-pericardiotomy syndrome (COPPS): a multicentre, randomized, double-blind, placebo-controlled trial. *Eur Heart J*. 2010;31(22):2749-2754. doi:10.1093/eurheartj/ehq319
22. Horneffer PJ, Miller RH, Pearson TA, et al. The effective treatment of postpericardiotomy syndrome after cardiac operations. A randomized placebo-controlled trial. *J Thorac Cardiovasc Surg*. 1990;100(2):292-296. doi:10.1016/S0022-5223(19)35571-0
23. Giacinto O, Minati A, Lusini M, et al. Treatment and prophylaxis of post-pericardiotomy syndrome in cardiac surgery patients: a systematic review. *Cardiovasc Drugs Ther*. 2023;37(4):771-779. doi:10.1007/s10557-021-07261-4
24. Malektojari A, Tahmasebipour R, Fadaeihosein M, et al. Pharmacological preventions and treatments for pericardial complications after open heart surgeries. *Heart*. (Published Online First) 2025. doi:10.1136/heartjnl-2024-324805
25. Fields JT, O'Halloran CP, Tannous P, et al. Differences in outcomes between surgical pericardial window and pericardiocentesis in children with postpericardiotomy syndrome. *Ann Pediatr Card*. 2023;16(6):422-425. doi:10.4103/apc.apc_108_23